

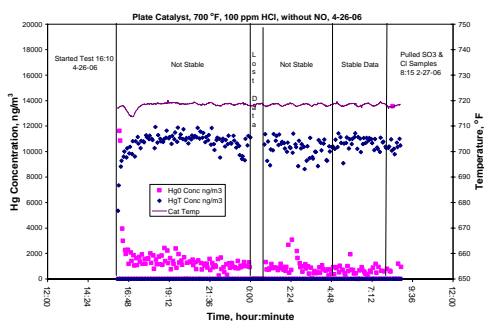
Oxidation of Mercury in Products of Coal Combustion

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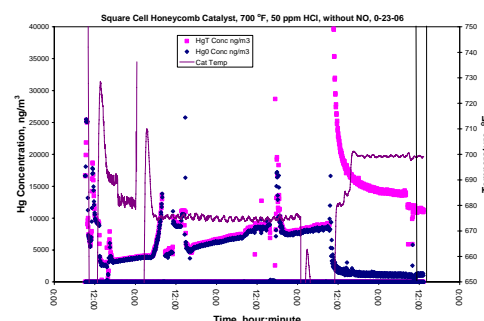
The objective is to maximize conversion of mercury from the elemental state to water-soluble mercuric chloride during selective catalytic reduction (SCR) of NO in coal combustion products from power boilers, while maintaining good NO reduction performance and minimizing oxidation of SO₂ to SO₃. The measurements are made at lab scale in the Catalyst Reactivity Test Facility at the Southern Research Institute. → Research needs in this area were reviewed by A. A. Presto and E. J. Granite, *Environ. Sci. Technol.* 40, **2006**, 5601.



← Implementation of the Tennessee Valley Authority's dry, high temperature mercury reduction system (S. J. Meischen et al., *J. A&WMA* 54, **2004**, 60) for determination of total mercury greatly improved the quality of the mercury measurements, reduced the time required to identify steady-state conditions, and increased the probability of success in each test run.



Measurements of elemental and total mercury using the conventional wet stannous chloride mercury reduction system are shown on the left. Measurements using the TVA system, on the right, show the improvement in data quality obtained using TVA's system.



Catalyst Properties and Conditions

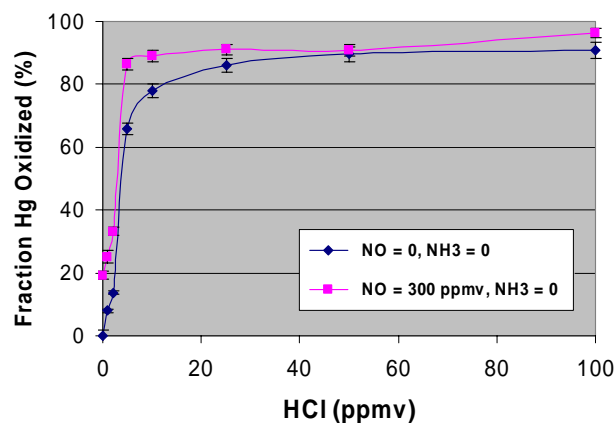
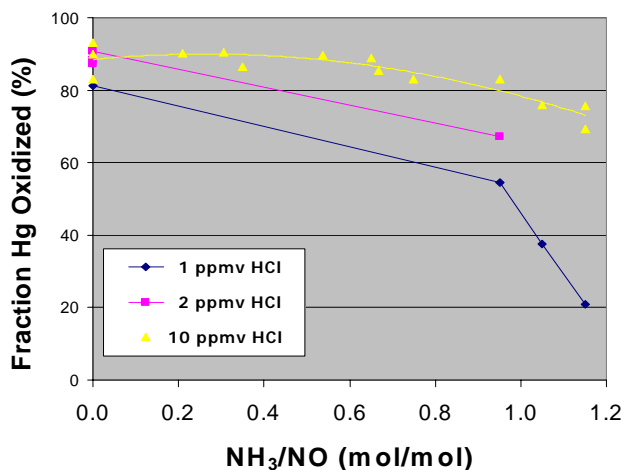
Temperature	371 °C (700 °F)
Catalyst length	286 mm
Catalyst channel cross section	square, 6 x 6 mm
Catalyst wall thickness	1 mm
Catalyst void volume	92.7 mL
Catalyst surface/volume ratio	667 m ⁻¹
Area velocity at 21 °C	4.5 m ³ /(h·m ²)
Space velocity at 21 °C	10,000 h ⁻¹
Gas residence time at 371 °C	0.16 s

Gas Composition

O ₂	5 vol%
CO ₂	15 vol%
H ₂ O	10 vol%
SO ₂	1000 ppmv
HCl	0 to 100 ppmv
NO	0 or 300 ppmv
NH ₃	0 to 345 ppmv
N ₂	~70 vol%
Hg	10,000 ng/m ³

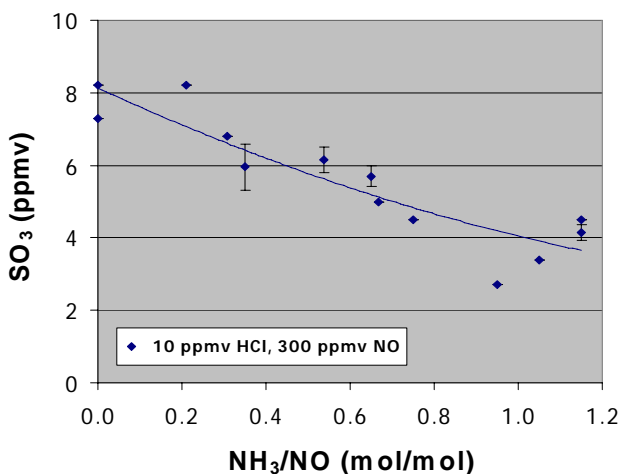
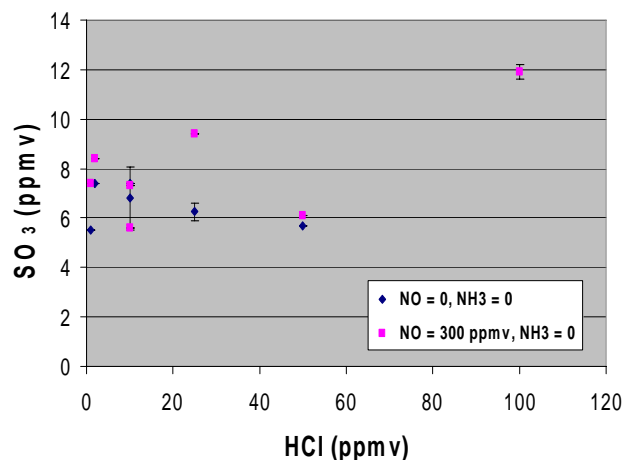
FT-IR has recently been implemented for determination of H₂O, HCl, SO₂, SO₃, H₂SO₄, NO, NH₃, CO, and CO₂.

The extent of mercury oxidation over the SCR catalyst rises → steeply from ~20% at 1-2 ppmv HCl, levels characteristic of low-chlorine subbituminous coals, to ~85% at 10 ppmv HCl. Over the range from 10 to 100 ppmv HCl, the fraction of mercury oxidized increases only by an additional 5 to 10%.



← Addition of NH₃ results in a gradual decrease in mercury oxidation at low NH₃/NO ratio, followed by a steeper decline in the presence of stoichiometric and excess NH₃, consistent with the predictions of S. Niksa and N. Fujiwara (2005) and C. L. Senior (2006).

Minimization of SO₃ formation is becoming an increasingly important factor in SCR performance. Measurements in the → absence of NH₃ are shown here as a function of the HCl volume fraction, grouped according to the presence or absence of NO. No clear trends with the changes in HCl or NO are evident. The average conversion is 0.75%, or formation of 7.5 ppmv of SO₃ from the 1000 ppmv of SO₂.



← Increasing NH₃/NO is associated with a reduction in gas-phase SO₃ at the sampling point. A method for capturing and determining NH₄HSO₄ and (NH₄)₂SO₄ aerosol is being implemented to determine total sulfate formation in the presence of NH₃.

Future Work: The next steps are to complete the experimental investigation of effects of NH₃/NO ratio on Hg and SO₂ oxidation at low HCl (1 and 2 ppmv) and determine the influence, if any, of CO in flue gas. The results will be interpreted using existing kinetic models (S. Niksa and N. Fujiwara, 2005; C. L. Senior, 2006) with additional diffusion, adsorption, and reaction processes as needed to explain the observations.

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